

The comparison of 24-hour urinary protein excretion and the urine protein creatinine ratio in obese and morbidly obese individuals

Urine protein/creatinine ratio in obese and morbidly obese individuals

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Abstract

Aim: Obesity is a major global health issue and a recognized risk factor for chronic kidney disease (CKD). Proteinuria, a key marker of renal function, is traditionally assessed via 24-hour urine collection, though this poses practical challenges. This study evaluated the correlation between spot urine protein-to-creatinine ratio (PCR) and 24-hour proteinuria in obese individuals, exploring the feasibility of using spot PCR as a simpler alternative.

Materials and Methods: A total of 178 obese individuals (BMI ≥ 35) were included in this prospective study conducted between August 2015 and October 2017. Individuals with conditions potentially affecting renal function were excluded. Proteinuria was assessed through both 24-hour urine collection and spot urine PCR. Correlation analyses were performed using Pearson or Spearman tests based on data distribution.

Results: The mean age of participants was 40.1 ± 11.5 years, with 75.3% being female. Proteinuria levels showed a moderate but statistically significant correlation between spot urine PCR and 24-hour urine protein excretion ($p = 0.003$, $r = 0.223$). However, in the subgroup with spot urine proteinuria ≥ 0.2 g/day, the correlation was not statistically significant ($p = 0.064$). BMI and proteinuria were weakly correlated, with results approaching but not reaching statistical significance ($p = 0.051$, $r^2 = 0.147$).

Discussion: Spot urine PCR demonstrates a moderate correlation with 24-hour urinary protein excretion and may serve as a practical screening tool for proteinuria in obese individuals. However, its reliability in cases of higher proteinuria requires further investigation with larger sample sizes.

Keywords

obesity, chronic kidney disease, protein-to-creatinine ratio

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This study was approved by the İnönü University Clinical Research Ethics Committee (Date: 2015-09-16, No: 2015/160.)

Introduction

Obesity has existed since ancient times and has been regarded as a symbol of wealth, prestige, and even beauty in different eras and regions. However, as the chronic health problems associated with obesity became increasingly recognized, it came to be classified as a disease requiring treatment. According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that presents a health risk. Despite its well-documented limitations, the World Health Organization (WHO) recommends the use of BMI in field studies on obesity [1,2]. A body mass index (BMI) over 25 is considered overweight, and over 30 is obese [3]. In 2019, an estimated 5 million noncommunicable disease (NCD) deaths were caused by higher-than-optimal BMI [4]. Over the past five decades, the global prevalence of obesity has steadily risen. A comprehensive analysis of body mass index trends among children and adolescents across multiple countries from 1975 to 2016 indicates a universal increase in obesity rates, albeit with some regional variations [5]. Current trends suggest that by 2025, the global prevalence of adult obesity will reach 18% among men and 21% among women [6].

Obesity is linked to numerous health complications, including hyperinsulinemia, lipid metabolism disorders, nonalcoholic fatty liver disease, coronary artery disease, cardiovascular conditions, various cancers, and chronic kidney disease (CKD) [7]. In recent years, the growing prevalence of obesity has contributed to its recognition as a significant risk factor for CKD. Data analysis from the UK Biobank indicated that a genetically estimated 0.06 increase in waist-to-hip ratio raises CKD risk by 30%, while a 5 kg/m² rise in body mass index (BMI) increases the risk by 50% [8]. Similarly, a 14-year cohort study conducted among Korean adults identified both elevated BMI and waist-to-hip ratio at baseline as independent risk factors for CKD development, confirming a strong association between obesity and CKD incidence [9].

In current clinical practice, protein excretion rate (PER) in patients with conditions such as diabetes mellitus, hypertension, and CKD can be assessed using various methods. Traditionally, PER has been assessed through timed urine collections, most commonly over 24 hours [10]. While PER has been regarded as the gold standard for evaluating proteinuria, the requirement to collect urine over an extended duration poses practical challenges. As a result, alternative methods such as the albumin-creatinine ratio (ACR) and total protein-creatinine ratio (PCR) in single, untimed urine samples have gained widespread use [10]. To date, no study in the literature has specifically examined the relationship between the urine PCR in spot urine samples and 24-hour urinary protein excretion in obese and morbidly obese individuals. This study aims to evaluate the correlation between the PCR in spot urine and 24-hour urinary protein excretion, assessing the reliability of the spot urine protein-to-creatinine ratio as a more practical alternative for proteinuria measurement in obese and morbidly obese individuals.

Materials and Methods

Patients and Design

The study included obese individuals aged 18 years and older

with a BMI ≥ 35 who visited the Nephrology, Endocrinology, and General Surgery Obesity outpatient clinics of İnönü University Faculty of Medicine between August 7, 2015, and October 11, 2017.

Initially, a comprehensive medical history was obtained, followed by thorough physical examinations of the patients. The history included the patients' complaints, coexisting systemic diseases (such as diabetes, cardiovascular disease, obstructive sleep apnea syndrome, and hypertension), and current medications, all of which were recorded. Patients with a history of chronic liver disease, chronic or acute renal failure, hypertension, diabetes mellitus, and urinary infection were excluded from the study. Information about the study was provided to the patients, and written informed consent was obtained. In addition to demographic data such as age and gender, BMI, height, and weight were measured and recorded.

Calculation Methods

Blood samples collected from the patients were analyzed for glucose, blood urea nitrogen (BUN), creatinine, uric acid, triglycerides, cholesterol, lactate dehydrogenase (LDH), high-density lipoprotein (HDL), aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and lactate dehydrogenase (LDH) levels.

Additionally, a complete urinalysis was performed, and spot urine samples were analyzed for microprotein and creatinine, while 24-hour urine samples were assessed for proteinuria. Imaging evaluation of the patients was performed using urinary system ultrasonography (USG)

The BMI of the patients was calculated using the TANITA device (TANITA TYPE TFB-300 M, Tokyo, Japan) based on the formula: BMI = Weight (kg) / Height (m²).

Proteinuria levels were measured in spot urine samples and 24-hour urine collections using the turbidimetric method with the Abbott ARCHITECT C16000 device (Abbott Laboratories, Abbott Park, IL, USA).

Patients began the urine collection process by excluding the first morning urine and continued to collect all urine until the same time the next day. The first morning urine of the second day was included in the collection, and the procedure was then completed.

Statistical Analysis

A power analysis determined that a minimum sample size of 42 participants was required to compare proteinuria levels in 24-hour urine samples and spot urine samples in obese patients, with a 95% confidence level and a 3% margin of error.

Statistical analysis of the research data was performed using SPSS for Windows version 22.0. Quantitative data were expressed as mean $\pm$ standard deviation (SD), while qualitative data were presented as counts and percentages (%). The Kolmogorov-Smirnov test was used to assess the normality of data distribution. For correlation analysis, Pearson's correlation test was applied to normally distributed data, while Spearman-Rank correlation test was used for non-normally distributed data. A p-value of ≤ 0.05 was considered statistically significant.

Ethical Approval

This study was approved by the İnönü University Clinical

Research Ethics Committee (Date: 2015-09-16, No: 2015/160).

Results

The study included 178 obese individuals, of whom 134 (75.3%) were female. The mean age of the participants was 40.1 ± 11.5 years (range: 18–74 years), with a mean weight of 120.9 ± 18.9 kg (range: 80.5–179.5 kg) and a mean height of 162.5 ± 9.9 cm (range: 124–193 cm). Proteinuria levels in 24-hour urine and spot urine samples were analyzed about BMI. The distribution of proteinuria among participants revealed that 136 (76%) individuals exhibited proteinuria levels below 150 mg/day, 33(18.5%) had minimally elevated levels (150–500 mg/day), 7 (3.9%)displayed non-nephrotic levels (500–3500 mg/day), and 1(0.5%) individual had nephrotic-range proteinuria (> 3500 mg/day). Proteinuria averages according to BMI are presented in Table 1. The correlation between BMI and proteinuria was assessed, yielding a p-value of 0.051 and an r² value of 0.147. Although the p-value narrowly exceeded the threshold for statistical significance, it was hypothesized that a larger sample size might yield statistically significant results. A correlation analysis was also performed to compare proteinuria levels derived from spot urine samples and 24-hour urine collections. This analysis demonstrated a statistically significant moderate correlation (p = 0.003, r = 0.223). Furthermore, for individuals with a spot urine proteinuria level of ≥ 0.2 g/day (n = 22), a comparison between proteinuria levels calculated from 24-hour urine and the spot urine protein/creatinine ratio revealed no statistically significant correlation (p = 0.064).

Discussion

Obesity is becoming an increasingly significant public health concern. It is now known that obesity increases renal protein and microalbumin excretion, even in the absence of comorbid conditions such as diabetes mellitus, hypertension, or chronic kidney disease. However, large-scale studies on the prevalence of this condition are lacking, and therefore its exact frequency remains unclear. In our study, we aimed to evaluate whether spot urine samples or 24-hour urinary protein excretion is a more suitable method for measuring proteinuria in obese patients. In a study conducted by Rosenstock et al. in 2018, the prevalence of proteinuria and albuminuria was found to be 21% and 19.7%, respectively. Among individuals without diabetes mellitus but with hypertension, the prevalence of proteinuria was 22.6%, and albuminuria was 17%. In patients with neither diabetes

mellitus nor hypertension, the prevalence of proteinuria and albuminuria was 13.3% and 11%, respectively [11]. Daily urinary protein excretion is measured by collecting 24-hour urine samples, which is considered the gold standard. However, due to the challenges associated with this method, including difficulties in implementation, potential measurement errors from improper urine collection, and lack of standardization in storage conditions, there has been a search for more practical alternatives. One of the more practical alternatives currently used in many diseases to assess proteinuria is the ratio of total protein to creatinine (expressed as mg/mg) in a random urine sample. However, the dipstick method used for measuring microalbuminuria may be considered insensitive in the early stages of increased glomerular permeability, as it is generally not expected to yield a positive result unless protein excretion exceeds 300–500 mg/day. A cross-sectional study investigating the association between obesity, central obesity, and increased urinary albumin-creatinine ratio included 2,889 participants. The study found an increased risk of elevated urinary albumin-creatinine ratio when comparing overweight and obese individuals to those with normal weight. Similarly, compared to participants with normal waist-to-hip ratios, those with central obesity also showed an increased albumin-creatinine ratio. The study further demonstrated a significant positive association between BMI and elevated albumin-creatinine ratio [12]. In our study, we found a weak correlation between the increase in BMI and proteinuria, which was not statistically significant. We attributed the discrepancy from the literature to our relatively small sample size. Although there is no study in the literature specifically comparing the reliability of spot urine samples and 24-hour urinary protein excretion for assessing proteinuria in obese patients, studies addressing this issue are available for patients with diabetes mellitus, certain rheumatologic diseases, and preeclampsia. In the study conducted by Demirci et al. on whether the spot urine protein/creatinine ratio could be an alternative to 24-hour urine protein in patients diagnosed with preeclampsia, 211 pregnant women meeting the preeclampsia criteria and 53 pregnant women in the control group were included [13]. A good correlation was found between 24-hour urine protein and the spot urine protein/creatinine ratio (r = 0.758). As a result, the spot urine protein/creatinine ratio was evaluated as a good predictor for proteinuria screening. According to this study, a spot urine protein/creatinine ratio of 1 g or higher appears to have high predictive value for the diagnosis of proteinuria and was concluded to be a rapid test that could be used to avoid delays in diagnosis in preeclamptic patients [13]. In another study conducted by Ralson et al. in a rheumatology clinic, the dipstick test, 24-hour urine quantitative protein measurement, and random urine protein/creatinine ratio were compared. The results showed a strong correlation between 24-hour total protein excretion and the random urine protein/creatinine ratio (r = 0.92, p < 0.001) [12]. In another study conducted by Mahaseth et al. in 2022, a linear relationship was found between the spot urine protein/creatinine ratio and the 24-hour urinary total protein, with a correlation coefficient of 0.877 (p < 0.01) [14]. However, at higher levels of protein excretion (>3.5

Table 1. Proteinuria averages according to BMI

BMI	24-hour urinary protein excretion (Mean ± SD)	Spot urinary proteinuria (Protein/Creatinine Ratio) (Mean ± SD)
30-34	0,11 ± 0,02	0,06 ± 0,02
35-39	0,10 ± 0,06	0,11 ± 0,06
40-44	0,30 ± 1,38	0,28 ± 1,44
45-49	0,13 ± 1,10	0,11 ± 0,11
≥50	0,17 ± 0,20	0,23 ± 0,34

BMI: Body Mass Index

grams/day), the correlation was observed to be suboptimal. However, there are also some studies that contradict these findings. In patients with chronic kidney disease, the study published by Sahu et al. in 2022 demonstrated that spot PCR can be a reliable parameter for the initial diagnosis of proteinuria. However, for follow-up measurements and in cases of proteinuria > 0.5 g/day, this correlation loses its significance, and 24-hour urinary total protein excretion is emphasized as the most accurate measurement [15]. In our study, a correlation analysis was conducted to compare proteinuria levels obtained from spot urine samples and 24-hour urine collections, revealing a statistically significant but moderate correlation ($p = 0.003$, $r = 0.223$). However, for individuals with a spot urine proteinuria level of ≥ 0.2 g/day ($n = 22$), no statistically significant correlation was observed between proteinuria levels calculated from 24-hour urine collections and the spot urine protein/creatinine ratio ($p = 0.064$). These findings suggest that in obese patients, the assessment of proteinuria using 24-hour urine collection provides a more accurate and reliable measurement compared to the spot urine protein/creatinine ratio.

Limitation

This study is subject to several limitations that warrant consideration, primarily the relatively small sample size, which may constrain the generalizability of the findings and necessitate larger-scale investigations to confirm these results across more diverse populations. Additionally, the reliance on spot urine samples collected at a single time point may not adequately capture temporal fluctuations, whereas repeated measurements would offer a more nuanced understanding of these variations. Notwithstanding these limitations, the present findings provide valuable contributions to the existing body of literature and highlight the necessity for further research in this domain.

Conclusion

Although the use of the spot urine protein/creatinine ratio appears to be reliable in certain conditions, such as rheumatologic diseases and preeclampsia, In our study, no statistically significant correlation was found between 24-hour urine protein levels and the spot urine protein/creatinine ratio in patients with proteinuria ≥ 0.2 g/g. The results of our study indicate that it is important to evaluate the reliability of spot urine protein/creatinine measurements on a disease-specific basis. This study concludes that assessing proteinuria using 24-hour urine protein analysis is more appropriate in obese patients.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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